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OPERATION SUN BEAM, SHOT SMALL BOY

Project Officer's Report—Project 7.1.4

Transient Radiation Effects Measurements on Guidance System Circuits

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NOTICE:
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OPERATION SUN BEAM

SHOT SMALL BOY

PROJECT OFFICERS REPORT — PROJECT 7.1.4

TRANSIENT RADIATION EFFECTS MEASUREMENTS ON GUIDANCE SYSTEM CIRCUITS

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DEPARTMENT OF DEFENSE
WASHINGTON 25, D.C.

1.4 DESIGN OF EXPERIMENT

Assuming a (fission) device detonated 10 feet above ground, circuit test locations were selected for dose rates of approximately However, Small Boy was later changed, after the instrumentation pads were installed, to a device of approximately yield. New estimates of the nuclear environment predicted at the station locations were obtained from Major Byron H. Shields, Program 7 Director, and were based on Los Alamos Scientific Laboratory (LASL) predictions for the device as calculated by the Biophysics Division of the Research Directorate, AFSWC.

The burst was treated as a surface detonation for both blast and thermal calculations, since the burst was only ten feet above ground level. In Reference 1 it was estimated that the total thermal radiation could be calculated from the following equation:

$$Q = \frac{2.6 \times 10^{11} \text{Cal/kt} \times \text{yield in kt}}{1.168 \times 10^{4} \text{ cm}^2/\text{ft}^2 \times R^2} \qquad (1.1)$$

$$Q =$$

Where: Q = thermal exposure, cal/sec

The times of air shock arrival and peak overpressure versus distance were derived by Sachs scaling of the surface burst curves given in Reference 2 to a yield of and to an altitude of 4200 feet (NASA standard atmosphere).

Estimates of the electric and magnetic fields used in subsequent calculations in this Chapter are taken from Reference 3.

For a nuclear weapon, the radius of the ionized region, a, producing the electromagnetic pulse was estimated from the relation

$$W = 4.55 \times 10^{-5} \; a \exp\left\{25 \left[1 - \exp(-0.1254a)\right]\right\} \qquad (1.2)$$

Where: W = yield Mt

a = effective radius, kilometers.

For the Small Boy event, a was approximately feet. At distances less than it was expected that there might be large electric fields of sufficient size to produce electrical breakdown in the ionized air. The electric fields for distances outside this region were estimated from the following equations:

$$E_{max} = \frac{3000\ a}{R} \left[1 - \frac{(a)^2}{R} + \frac{(a)^4}{R} \right]^{\frac{1}{2}} \quad (1.3)$$

Where:

E_{max} = peak electric field, volts/meter

a = effective radius, feet

R = distance, feet

Low-frequency magnetic fields could not be predicted reliably. The maximum value for the high-frequency horizontal component was estimated from the equation:

$$H_\phi = \left[100 \frac{W}{R^2} \quad \exp. \quad (-2.5R) \right]^{0.43} \quad (1.4)$$

Where:

H_ϕ = horizontal component, oersteds

R = distance, kilometers

W = yield, Mt

The maximum rate of change of the magnetic field was estimated from the relationship:

$$\frac{dH_{Max}}{dt} = 10^6 \quad H_{max} \quad (1.5)$$

Where:

H_{max} = magnetic field

t = time, seconds

Fallout doses were estimated using TM-23-200 (Reference 4). The ground shock parameters were taken from Brode's report (Reference 5) on protective construction.

Table 1.1 summarizes the predicted environment at each station location.

The blooper and diagnostic stations on this equipment were designed to reduce all associated weapon environments such as thermal, blast and EMP, to below damage-threshold levels for the circuits and instrumentation involved.

Thin aluminum fallout covers were installed at each pad to minimize contamination of the package between H-hour and recovery time. Each diagnostic and blooper package was placed in a 1/4-inch-thick steel box to prevent damage from blast and over-

TABLE 3.2 GENERAL SHOT DATA, SHOT SMALL BOY

Device	
Yield	
Date	14 July 1962
Time of detonation	11:30 00.123 PDT
Burst Medium	Air
Actual Height of Burst	10 feet
Placement	Wooden Tower
Nevada State Coordinates	N 747,907.43
	E 717,118.39
Surface Zero	Ground
Air Pressure at Surface GZ(Hg)	26.67
Air Pressure at Surface GZ(Mb)	904
Air Temperature (°C)	31.7
Relative Humidity (%)	16
Dew point (°C)	2.8
Surface wind direction/Velocity °/Mph	225/06

pages 100 through 105 deleted.

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